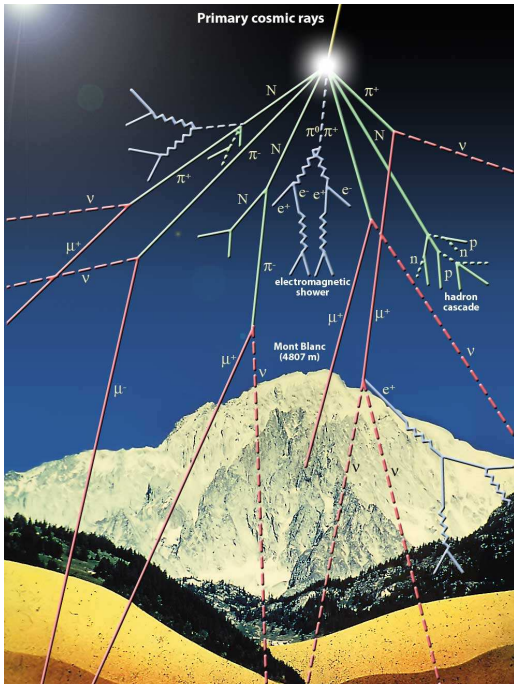


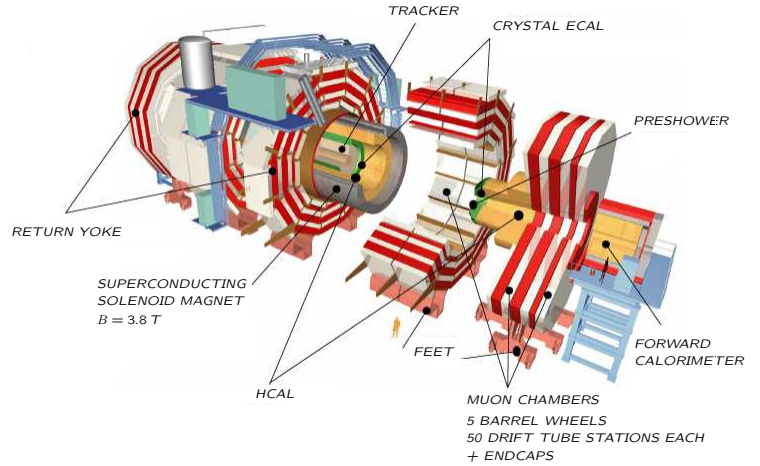
Lars Sonnenschein
on behalf of the CMS collaboration

A measurement is presented of the flux ratio of positive and negative muons from cosmic ray interactions in the atmosphere, using data collected by the CMS detector at ground level and in the underground experimental cavern. The excellent performance of the CMS detector allowed detection of muons in the momentum range from 5 GeV/c to 1 TeV/c. For muon momenta below 100 GeV/c the flux ratio is measured to be a constant $1.2766 \pm 0.0032(\text{stat.}) \pm 0.0032(\text{syst.})$, the most precise measurement to date. At higher momenta an increase in the charge ratio is observed, in agreement with models of muon production in cosmic ray showers and compatible with previous measurements by deep underground experiments.

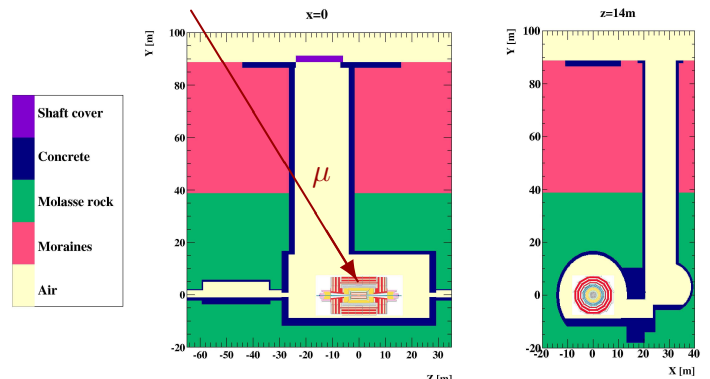
Muon production in atmospheric showers



The CMS detector

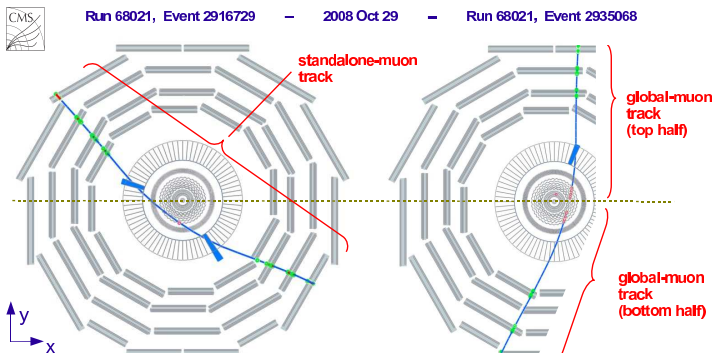


CMS and surroundings



Cosmic-ray muons are propagated through different materials of the CMS infrastructure and surrounding geological layers

Cosmic-ray muons crossing the CMS detector

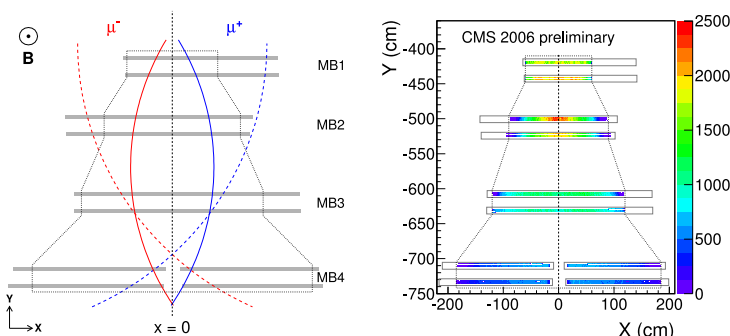


CMS underground (2008) event displays

Three CMS cosmic-ray muon analyses combined

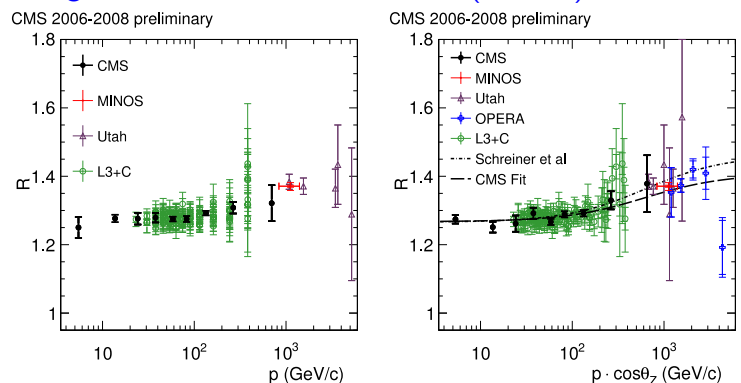
- CMS at surface (2006): $3.3 \cdot 10^5$ standalone-muon track events selected
- CMS underground (2008): $2.45 \cdot 10^5$ global muon track events selected
- $1.6 \cdot 10^6$ standalone-muon track events selected

Muon system and symmetric fiducial volume



Bottom sector: left-right symmetry and CMS at surface (2006) hit distribution

Charge ratio as a function of muon (vertical) momentum



$$R(p_\mu < 100 \text{ GeV}/c) = 1.2766 \pm 0.0032(\text{stat.}) \pm 0.0032(\text{syst.})$$

$$R(p_\mu \cos \theta_z < 70 \text{ GeV}/c) = 1.2728 \pm 0.0039(\text{stat.}) \pm 0.0040(\text{syst.})$$